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Bulletin of the

Society for the Promotion of Engineering Education

VOL. X LANCASTER, PA., JUNE, 1920 NO. 10

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BULLETIN

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ARTHUR M. GREENE, JR., PRESIDENT, THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, 1919–1920.

President Arthur M. Greene, Jr., B.S., M.E., D.Sc., has been closely associated with the development of engineering education in the United States.

Born in Philadelphia, in 1872, he was educated at the Manual Training School, from which he was graduated in 1889, and at the University of Pennsylvania, from which he received the degrees of B.S. and M.E. in 1893 and 1894. Since then he has made himself familiar with European methods.

As an educator he has had a wide experience in various institutions differing in character and equipment. After directing the apprentice school of the Franklin Sugar Refinery for two years, he became instructor at the Drexel Institute in 1894. Returning to his *alma mater* in 1895, he remained in Philadelphia until 1902, when he was appointed professor of mechanical engineering in the University of Missouri. While junior dean of the School of Engineering, he was called to the Rensselaer Polytechnic Institute, in 1907, to organize the Sage School of Mechanical Engineering. Since then he has devoted himself untiringly to the tasks of his position.

In spite of this fact he has found opportunity to supplement his well-known "Elements of Steam Engineering" (with H. W. Spangler and S. M. Marshall) by valuable books on pumping machinery, heating and ventilation, heat engineering, and refrigeration.

As a member of the great scientific associations of America, he has also contributed materially to the advancement of his profession. In the Engineering Council and the Committee of Technical Societies especially he has helped to solve many problems resulting from the War. Of the Society for the Promotion of Engineering Education he has always been a loyal supporter.

REPORT OF COMMITTEE NO. 13, MECHANICS AND HYDRAULICS.

CORRELATION OF COURSES.

BY O. H. BASQUIN,

Northwestern University, Evanston, Illinois.

On May 3 and 4, 1920, a conference was had at Iowa City, Iowa, between Professor Stewart, chairman of the Committee on Physics, and Professor Basquin, chairman of the Committee on Mechanics and Hydraulics.

The topic of discussion was Correlation of Courses, particularly Correlation of the Mechanics Portion of General Physics and the subsequent course in Mechanics, and still more particularly whether the proposed coöperation of the two committees in making a combined syllabus, table of contents or dictionary, is appropriate and practical.

These notes are intended to record briefly some of the views of the chairman of the Committee on Mechanics and Hydraulics.

Two courses of instruction may be said to be correlated if each instructor understands the aim of the other and if he so plans his instruction as to accommodate the aim of the other instructor as well as his own.

Lack of correlation appears to be a natural result of specialization and of the division of the forces of instruction into separate departments according to topics of specialization. In specializing one narrows his point of view to his own topics; his judgment becomes excellent on these topics but it may be poor on others. Instructors in allied departments naturally develop different points of view; they take pride in developing superior points of view and they naturally plan their instruction to suit the points of view of their own departments. Thus arises a lack of correlation.

In a comparatively young institution the lack of correlation is likely to be less marked. The number of departments is smaller; specialization has not become so marked; the small number of instructors gives each a better opportunity to learn the views of others, and it is possible for each instructor to see that the success of the institution depends more upon coöperation than upon brilliant teaching in one topic that may not fit into the general plan.

The lack of correlation is therefore looked upon as the natural result of the common plan of organizing highly specialized instructors into separate departments. Assuming that the lack of correlation exists, how may this lack be overcome? How may correlation be introduced?

There seems to be a tendency in some institutions to demand that engineering students shall receive their instruction from engineering instructors, men of engineering training if not of engineering experience. A few years ago, the students of medical schools received practically all their instruction from medical instructors; this is now in process of change to a scheme whereby liberal arts instruction is required of such students before entering medical schools. It is not evident that engineering students can afford to miss the liberalizing influence that may come from contact with instructors who are not engineers; it is not believed that this plan for the introduction of correlation is of general application.

Further, it is not believed that a suggestion that instructors should be less highly specialized or that any radical change should be made in their organization into departments would be received with favor by any considerable number of institutions. The present arrangements correspond to some extent to modern methods of manufacture wherein distinct processes are conducted by specialists in distinct departments.

The method of manufacture appears to differ from the college organization in that the material operated upon is much more tangible than that upon which instructors work;

inappropriate treatment of this material is thus easily detected in manufacturing whereas it is scarcely evident in education and its result may be attributed to the wrong cause. The differences pointed out naturally lead to closer coöperation between departments in manufacturing than in education; and in manufacturing that differences of opinion between departments leads to a prompt and effective decision by the administration: differences of opinion in manufacturing are not allowed to interfere with consistent processes.

In college organization the different departments in one college are supposed to be bound together by the dean of that college; it is his business to see that the departments work harmoniously; that their instruction be correlated. The dean's authority may not extend beyond his own college. If correlation is to be established between two departments in different colleges, it seems necessary, according to the rules, to enlist the influence of the deans of both these colleges in favor of such correlation, or to carry the question to the president of the institution. This is an awkward process for the purpose, to say the least. But since these officials represent the correlating influences in the organization, I think it essential that they realize that effective correlation can become general only through their action in its favor.

If the instructors in two courses desire to establish correlation in their work, what is to prevent their doing it? The conditions for correlation are given in the fourth paragraph of these notes. The instructors are on the same campus; they meet frequently; a few conferences on the subject will make clear to each instructor what the general aim of the other is; an exchange of textbooks with marks at important parts will lead to a thorough understanding. Given the desire to introduce correlation, I see no considerable obstacle to its effective and prompt introduction. The one lack is the *desire;* the desire on the part of *both* instructors. To introduce correlation, the first thing that is to be supplied is the desire to do it. I think that this will not arise in the minds of both men spontaneously and simultaneously. This desire must come from

another source. It must come from the correlating official of the institution. Each instructor must be told by his own dean that correlation must be introduced; that the dean does not care how differences of opinion are settled between the departments, but that consistent instruction must be introduced without delay.

Professor Mann's Report on Engineering Education contains an interesting account (page 30) of the means used at University of Cincinnati to develop "a very effective coördination of effort among the several departments." It is there stated that similar efforts are being tried at Sheffield Scientific School and at Stevens Institute.

The course in General Physics is commonly given to engineering students in the sophomore year; about 30 per cent. of the time for this course is devoted to the study of mechanics. Mechanics is an essential part of physics because other parts of physics are not considered as explained satisfactorily until they are solved in terms of mechanics. This study of mechanics covers the fundamental principles, it commonly embraces experimental lectures done before large classes, some individual laboratory work, recitations on a text, and the solution of some problems. This work is conducted, in general, under the direction of the physics department.

Instruction in mechanics is continued in a separate course and quite commonly under the direction of another department. In this further work the main object is to give the student a working knowledge of the subject whose fundamental principles have been studied already. Comparatively few new principles are taught the student in this second course, but many applications are made. It is customary to use a different text from the one used in Physics and in this text the subject is treated as a whole, *de novo;* the principles are again explained (perhaps using more mathematics and a somewhat more advanced view) instead of referring the student to his former text.

The teachers in this mechanics course may be young engineers with a couple of years of practical experience; they may

not know the points of view of the physics instructors in that institution and they may care less; they may have found that certain points of view in mechanics have been essential in their experience in practice and they are determined to make these points clear to their students. This mechanics course differs from the physics work in that subject, in point of view and in method of instruction—the solution of numerous problems of a practical nature.

In January, 1917, the Physics Committee made a report to the Committee on Mechanics, in part, as follows:

"The Committee on Physics very much regrets the general lack of coöperation between the two courses in mechanics . . . ."

"It realizes that this lack of coöperation is due to the lack of knowledge (on the part of the instructors in physics) of succeeding engineering courses and of actual engineering problems, to the lack of knowledge (on the part of the instructors in mechanics) of the material studied in the course in physics, to the apparent lack of knowledge on the part of the student in passing from one course to the other, and to the lack of recognition of the necessity of repeated reviewing if the student actually is to acquire a *working knowledge* of mechanics."

"It realizes that coöperation in the preparation of a syllabus on *mechanics* is highly desirable as a method of influencing the coöperation which should exist between the two courses."

The report closed with a recommended plan for the preparation of the joint syllabus. The former Committee on Mechanics approved the undertaking. In December, 1917, the Committee on Physics presented to the Committee on Mechanics its portion of the proposed joint syllabus on Mechanics; and the approved plan provided that the Committee on Mechanics would furnish additional material indicative of the work of the second course in mechanics. This material was not furnished promptly and the Committee on Mechanics was reorganized the following June. The following December the

matter of the joint syllabus was brought to the attention of the present Committee on Mechanics and Hydraulics. This committee had other work laid out for last year. Its position regarding the proposed syllabus has been unsatisfactory; apparently its members looked upon it as work that ought to be done out of courtesy to the Physics Committee and because the preceding Committee on Mechanics had approved the undertaking. However, no member showed enthusiasm and all appeared to be busy with duties that seemed more important. The matter was brought to a head by the request by Chairman Stewart for the conference referred to at the beginning of these notes.

The writer does not believe that the preparation of the proposed syllabus would have any material influence in bringing about the desired correlation of courses. Correlation in any one institution should be made by the adjustment of courses to one another as they are actually given in that institution, and not by the adjustment to some proposed standard that does not fit the condition that are present in any one institution. The proposed syllabus does not supply the motive for correlation in any one institution, whereas the writer believes that the motive for correlation is the one essential requirement for its establishment. The Physics portion of this proposed syllabus has been in existence for over two years and in the hands of men in mechanics; I have not learned that any mechanics course has been correlated to the Physics portion of the syllabus, whereas it seems to me that this would have happened in some institution and that such would have been reported if this material contained the key to the solution. Correlation of these two courses has not taken place at the State University of Iowa, where this proposal appears to have originated. If this matter were of compelling influence, it seems to me that it ought to have shown some effect at its source before this date.

The writer believes that the subject of correlation of courses is worthy of the attention of the Society. He believes that a campaign should be organized for the purpose of calling at-

tention to the importance of the subject and to the necessity of securing the assistance of the proper officials to provide the motive. He thinks that papers should be published upon the attempts that have been made to secure correlation in various institutions with the results obtained, and that definite institutions be approached for the purpose of having experiments in correlation attempted for the good of the institution and for the information of the Society in attempting to develop this work.

REPORT OF COMMITTEE 14, ECONOMICS.

The Committee was assigned no specific work by the Society and has no definite recommendations to make, but desires to submit as information certain observations concerning the teaching of economics to engineering students.

These observations are not intended to be recommendations as to methods of teaching, for teachers of economics have their own methods; they are rather meant to indicate the results which in an engineer's judgment, may be most beneficial.

Point of View in Teaching Economics to Engineering Students.

In this connection, the following statements of opinion are offered by the Committee:

1. The introductory course of three credit hours as recommended in the 1918 report, should consist essentially of the elements of economics, and be of such a content that it might satisfactorily serve as a basis for further study in advanced courses.

2. In the adjustment of time given to the major divisions of the subject, primary emphasis should be placed on Production.

3. Anything in the nature of *applied economics* as related to engineering, should be administered through the regular engineering departments just as the applied physical sciences are administered.

In support of this opinion, attention may be called to the fact that most textbooks as well as most professors of economics at present are chiefly or primarily concerned with the *distribution* of the nation's wealth and the products of industry rather than with the production of this wealth, and therefore, they stress the former phase of economics above the others. Exchange and commerce and the agencies thereof

probably take second place in their estimation and consumption with the consideration of the nature of human wants and the elements of value assigned to third place, leaving production to receive the least attention of the four major divisions of the subject of economics. This is not their relative order of importance as they pertain to the profession of engineering. The engineer is more concerned professionally with production of the foods than he is with the equitableness of their distribution, his interests in the latter being that of any citizen. He is interested, therefore, in the economic forces which stimulate or retard production. Are personal initiative and group efficiency promoted by private control of the sources of production rather than by government control to the end that production is increased and made more efficient? What taxes are purely fiscal and what are regulatory and do some forms of taxes unduly retard production? Is output restricted and diminished by certain laws intended to regulate industry? What effect do adequate facilities for commerce have on production? Do combination of capital on the one hand and the unionization of labor on the other affect production? Do high wages with better standards of living increase production over low wage conditions? This sort of questions illustrates the professional viewpoint of the engineer with regard to economic questions. For example, the engineer professionally is primarily interested in wages as they affect production through their influence on workmen's efficiency and otherwise rather than in the general social problem as to whether they represent the just share of the products of industry that should go to labor. In the latter, he is interested as a worker himself and as a citizen, but the former phase bears on his professional activity. For this reason it is less important for the engineering student to study at great length the various economic factors that determine labor's return than it is to know the agencies which under existing conditions actually fix wages. That is, it is less important for him to follow through the arguments of those on the one hand who believe that labor's share of the products of industry (wages) is determined by "marginal

utility" or "marginal productivity" of labor and of those on the other hand who contend that the 'living wage" theory as advanced by Marx, Ricardo and Smith is the determining factor, than it is for him to know that wages are actually determined in any industry by the facilities for bargaining between employees. The engineer is interested primarily in profit sharing, industrial partnership, etc., in so far as these devices may affect labor turnover, labor efficiency and ultimately, on the cost and quantity of production. In other words, the Committee feels that valuable time may be unwisely. spent in classes of engineering students with comparatively immature judgment in a discussion, as the primary basis of a course in economics, of many of the advanced socialistic notions of distribution rather than in the consideration of the fairly well-established principles of productive industry and of commerce.

Attention should be called also to a possible danger that may arise in leaving an engineering student with only a brief outline or survey of economic thought which must necessarily be rather superficial, unless such survey has been skillfully administered. This student is not, generally to have the benefit of further formal studies in economics, hence, the instruction should be made as pointed and definite as possible, and loose ends of ideas and concepts should be caught up and such concepts cleared and chastened perhaps more systematically and rigorously than in the case of liberal arts students who intend to delve more deeply into the philosophy of economics. Unless this is done, inaccurate and muddled thinking may be the result of the course instead of clear cut logic that is so much desired. Economics deals largely with general averages, and the student with a smattering of economic factors may talk glibly of glittering generalities, about "movements," "trends," "tendencies," "waves," "tides," "streams," "currents," "drifts," etc., and yet may mistake a patch on a man's trousers for a "wave of economy." Therefore, accuracy of observation, clear and direct thinking, and discerning judgment in analysis should be striven for in instruction,

with an effort to separate the relevant from the irrelevant, in considering any particular question, rather than to arrive at certain preconceived conclusions of more or less dogmatic character, which may after all, be more dependent upon the professor's experience and training than upon an unbiased survey of facts. Most questions of political and social organization, after being brought to the attention of the class and having their significance indicated, instead of being "settled" by the teacher, would best be left to the further reading and observation of the student with the mental road left open for each to arrive at his own final conclusions.

Improved Psychology in Teaching Economics.

That a good deal of time has not been well spent in the teaching of economics in attempting to project modern motives and wants back into primitive conditions of social organization is doubtless a fact. A consideration of modern motives, wants, processes and methods together is certainly more rational than to attempt to draw conclusions from the application of modern motives to primitive methods, because the motives that actuate men change with the development of social organization. Whereas a savage was actuated almost solely by elemental desires, the modern man is actuated by a complexity of wants, both natural and artificial, arising from the complex means of supplying and satisfying them; hence, to attempt to arrive at safe conclusions applicable to modern society by projecting present day motives back to the conditions of savages swapping nuts for fish, building a wigwam, making clothes of skins and bark, or of Cruso's relation to his man Friday, may be agreeable mental diversion, but is likely to be barren of usable results applicable to existing conditions.

Happily this sort of teaching of economics does not prevail to the extent that it once did, and both texts and professors devote their discussions more to actual conditions of the present industrial and social world, and attempt to connect modern complex wants and elements of value to the existing complex modes of supplying them, and to recognize, for example, the

function of business ability and of organization as applied to quantity production as distinguished from the crude coöperation of a few members of a savage tribe.

The average engineering student is not familiar with business methods and the agencies and instrumentalities for conducting the economic and industrial affairs in the modern world and the instructor should take advantage of every opportunity to impart instruction along this line by using as illustrative material definite and accurate information concerning commercial processes instead of framing hypothetical and unreal situations as they may occur to him at the moment. It is true that to teach a class in this manner will require special effort on the part of the instructor even though he may be able to discuss generalities from his knowledge of the subject. The chief cause of the lack of interest on the part of engineering students is due largely to the pointless instruction of instructors who lecture out of their inner consciousness and general knowledge of the subject rather than put forth the effort to prepare specifically for this elementary instruction.

Present Status of Courses in Economics.

Two years ago, this Committee recommended that a three semester hour course in general economics be required of all engineering students, and submitted a tabular statement of the prescribed courses in economics at various institutions at that time. A revised study of conditions indicates that a few schools not requiring economics then have since introduced courses and that apparently none have reduced the amount of time devoted to the subject. Some have introduced courses in what may be termed *applied economics,* such as management, administration, costs and ratemaking, valuation, etc., taught by members of the engineering faculty. The opinion of the Committee, based on the observation of only a few cases, is that these latter courses, where taught by a professor of engineering of broad professional experience, are of much value.

As indicated in the 1918 report of this Committee, some

engineers and writers appear to confuse *economy* or *economics of design, construction and operation,* which takes into consideration the factors affecting the cost and financing of engineering projects, with *economics* or *political economy* as the term is employed by collegiate faculties. There is a danger of rendering the term *economics threadbare* and meaningless by its promiscuous use, and this resulting vagueness of the term has apparently led some to suppose that collegiate departments include many subjects in their curricula which as a matter of fact they are not equipped to teach nor do they make any attempt to do so.

Combined Courses of Commerce and Engineering.

Somewhat over a year ago, certain conferences were held under the direction of the Bureau of Education to foster the development of courses involving a combination of technical subjects with economics as preparation for managerial positions. A few schools have instituted such courses, as related in last year's report, and this list has been slightly increased during the year. All these courses, except perhaps that at Carnegie Institute of Technology, are fundamentally courses in engineering with economics and similar subjects substituted for some of the more highly specialized technical subjects. In one instance, at least, the courses in economics are added as a fifth year to the regular engineering curricula, and in another, the combined course is of six years duration coördinate with the other technical courses at the same institution.

While the Committee is not prepared to offer an opinion as to the feasibility of such courses generally, it appears that the interest, as indicated by the number of students enrolled in them, is greater in the populous manufacturing and commercial centers than it is in the mid-west institutions. Massachusetts Institute of Technology, for instance, reports a growing enrollment in its course in Engineering Administration, while two mid-west universities have practically no demand for similar courses. This is the situation that would naturally be expected from the circumstances.

The Committee believes that the application of the term "Commercial Engineering," as proposed by the Bureau of Education to courses in schools of commerce, which include a small amount of informational study in engineering methods and processes, is undesirable, because "engineering" has through the past century taken on a fairly well defined meaning, and to apply it loosely to the specific operations and procedure of commerce, to salesmanship, of miscellaneous goods, to advertising, accounting, etc., is but rendering the term more meaningless as signifying a profession.

J. W. DIETZ,
A. B. MCDANIEL,
E. B. PAINE,
P. F. WALKER,
C. C. WILLIAMS, *Chairman,*
Committee.

The Committee begs to submit as an Appendix to the above report, the following brief paper on "Teaching Elementary Economics to Engineering Students" by William M. Duffus, associate professor of economics at the University of Kansas, who has taught the economics classes for engineering students at that institution during the past year, and who has given considerable thought to the character of instruction best adapted to the conditions.

TEACHING ELEMENTARY ECONOMICS TO ENGINEERING STUDENTS.

BY WILLIAM M. DUFFUS,

Associate Professor of Economics, University of Kansas.

In compliance with the Committee's request the writer is glad to state some of the opinions which he has formed concerning the problem of teaching economics to students of engineering. However, he wishes it understood that his opinions are the result of but one year's experience with the problem and that some of them are tentative conclusions rather than expressions of final judgment.

First of all, it seems to the writer, the committee is to be congratulated upon its discernment in emphasizing the necessity for thorough drill in what are generally accepted as the fundamental principles of economics. The engineer, if he is to rise to his opportunities for personal advancement and for service to others, needs to have a good grasp of these principles and a reasonably accurate knowledge of the nature and problems of modern economic institutions. He can best get these aids to efficiency as the rest of us can best get them—by the study of economic forces and economic institutions as they are found in the world at large. It is no more possible to *divide* the *principles* of economic science successfully into economics for business men, economics for farmers, economics for engineers and economics for apothecaries than it is to divide the principles of the physical sciences in the same way.

Although all students studying economics need to study the same fundamental economic principles, whatever the professions for which they may be preparing, they do not all need to approach the subject in the same way. In fact there are distinct advantages in using methods of approach which differ more or less in accordance with the experience, maturity and interests of the student. The maintenance of courses exclusively for students of engineering would seem to be an aid to good instruction.

It must also be admitted that *after* the student acquires a knowledge of the fundamental principles of economics he may reasonably be permitted, within pretty broad limits, to apply that knowledge and make further inquiries in the fields of economic activity in which he is professionally most interested, even though he has to neglect other fields. To illustrate, the student of agriculture may reasonably be given special instruction in rural credits and the marketing of farm products; the student of engineering may just as reasonably be given special instruction in the problems of industrial relations, the regulation of railroads and public utilities, and the organization and financing of business enterprises. But, it may be remarked parenthetically, there will be little opportunity for any instruction in these or in certain other very important phases of economics as long as the present limitation of the time given to economics to a maximum of three hours per week for one semester prevails. The writer earnestly believes that the extension of the time for the course from three to five or six hours would more than double the value of the course.

Taking the situation as it stands, the use of the class discussion method of instruction, with assigned readings in one textbook and in one or more books of readings and frequent short written quizzes, will probably give the best results. There should be at least one section for every 35 or 40 students. The instructor, especially at the outset of his work, should make an especial effort to explain specifically how and why a knowledge of economics is essential to the engineer and should point out from time to time as he develops his subject the importance of the different phases of it to the engineer. He should be as direct and concise as possible in his own share in the class discussion and should use concrete and up-to-date illustrative material. He should avoid the elaboration of fine-spun theories in matters of controversy in so far as it can be done without sacrificing scientific accuracy. For it must be remembered that the student of engineering is training himself for a very practical life and not for a life as a speculative philosopher.

It is probable that a textbook especially designed to meet the needs of students of engineering would be a material aid, if properly written, in the teaching of economics for engineers. Such a book should be written by an economist who has had experience in teaching engineering students and who knows something of their psychology and the difficulties which they have in grasping the subject. It should be written with the point of view of the student constantly in mind. It may be difficult, however, to induce any competent economist to undertake the task as long as the present time limitation on the work of the course remains effective.

The writer has used Ely's "Outlines of Economics" as the text this year and has assigned additional readings in Marshall, Wright and Field's "Materials for the Study of Elementary Economics." Such collections of illustrative material as are found in Marshall's "Readings in Industrial Society," Hamilton's "Current Economic Problems" and some of the more specialized books of readings might well be used as additional references. The writer has found it inadvisable to depend upon any one book of readings. In fact he is among those instructors who are desirous of seeing some plan for the provision of loose-leaf, up-to-date illustrative material worked out as an experiment. In this connection readers may be interested to know that a committee of members of the American Economic Association, chosen from among instructors of elementary classes in universities and colleges, is studying the possibility of establishing such a plan.

There is a disposition among some teachers of economics to regard students of engineering as particularly hard to teach. The writer's experience does not warrant this belief. If the instructor receives proper support from the school or departments of engineering and if he approaches his subject with proper consideration for the psychology of his students and with proper enthusiasm on his own part he should be able to obtain results that will compare favorably with those obtained in teaching academic students or students preparing for commercial pursuits.

REPORT OF COMMITTEE NO. 15, CIVIL ENGINEERING.

SUBJECT: METHODS AND DETAILS OF TEACHING STRUCTURAL DESIGN.

The above subject was assigned to the Committee nearly three years ago. A progress report including three formal papers, was presented at the Evanston meeting which, with discussion, appears in the 1918 *Proceedings*. The work was continued during the following year primarily by means of discussions by Messrs. C. E. Fowler, J. A. L. Waddell, H. P. Gillette, Gustav Lindenthal, O. H. Basquin, S. C. Hollister, Edward Godfrey, and F. E. Schmitt. These were published in the April and May (1919) numbers of the BULLETIN, but not in the *Proceedings*.

A report, which was regarded by the Committee as a final one, was presented at the Baltimore meeting which, with discussions was published in the 1919 *Proceedings*.

This report contained a "Summary of Conclusions" which, by vote of the meeting was made a part of the program of the 1920 convention for discussion and possible adoption.

The Committee has given an attentive ear to the discussions and, with further study, takes the liberty to make one slight change and two additions to the Summary as presented a year ago. It therefore presents, for approval by the Society, as the principles which should be considered in planning and administering the structural courses of a curriculum in Civil Engineering:

1. The general curriculum in Civil Engineering should be fundamental in character and broad in scope.

2. The structural courses should be considered as a part of the general curriculum and not as independent courses.

3. The structural courses should be so comprehensive and

at the same time so fundamental that they will enable the student to understand the main features of the design of structures and, at the same time, serve as a basis for future specialization in college or in practice.

4. The required structural courses should include:

(*a*) Mechanics, including statics, dynamics, and mechanics of materials.

(*b*) An experimental and physical study of the usual materials of construction, including iron, steel, timber, cement and concrete.

(*c*) The theory of reinforced concrete construction with just sufficient design to illustrate and fix the principles involved.

(*d*) An analysis of stresses and deflections in framed structures from a general standpoint which may be extended, when desired, to any structure, for dead and live loads.

(*e*) The principles underlying the design of sections and of details with just sufficient work in design to illustrate and fix those principles.

(*f*) An introduction to the principles of estimating and to the procedure of producing structures.

5. Electric structural courses should be provided in accordance with the policy and the needs of the individual institution.

6. The methods employed should be such as to arouse the student's interest and be directed towards the discovery and development, by the student, of the principles involved, rather than to "teach" him certain standard theories and methods.

The slight change mentioned above consists of dropping the words "statically determinate" which preceded "structure" in 4 (*d*). The discussion has brought out the fact that in a number of required courses including those given by two members of the committee, the stress work has been extended to some statically indeterminate conditions with apparent success. The change does not necessarily recommend

this procedure, but it specifically removes a recommendation that statically indeterminate work be excluded.

4 (*f*) was added to meet a demand, championed particularly by Professor McKibben at the Baltimore meeting, for giving the student an insight into the shop and managerial problems involved in producing structures and for calling attention to the need of considering estimates in connection with the structural courses unless provision has been made elsewhere in the curriculum.

5 has been added to cover the demand from certain sources for additional work. The committee feels that further requirements in structural lines, accompanied by similar ones in railroads, water supply, sewerage, etc., would defeat the purpose of a strong fundamental course, but recognizes that a certain amount of specialization may be desirable for some men at some places and that this can best be provided for through electives.

Respectfully submitted,

A. H. FULLER, *Chairman,*
W. C. HUNTINGTON,
H. T. BURT,
C. T. MORRIS,
J. HAMMOND SMITH,
Committee No. 15.

THE EFFECT OF RAILWAY CONDITIONS ON CIVIL ENGINEERING CURRICULA.

BY CLEMENT C. WILLIAMS,

Professor of Civil Engineering, University of Kansas.

In a recent number of a technical periodical appeared the rather startling statement by the head of the civil engineering department at one of our great universities that no work in railway engineering was required at that institution in the civil engineering course but that all railway work offered there was elective. The statement was all the more noteworthy because this eminent professor is a civil engineer of established reputation, who has entered the educational ranks within comparatively recent years, and therefore, is perhaps least biased in his thinking by educational tradition, and also, because he is preëminently a railroad and construction engineer. The reason given for such attitude was the lack of favorable consideration of technical graduates by the railroads in their engineering departments.

This brief discussion is not intended primarily as a comment on the action at the above mentioned institution, but the statement merely accounts to a certain extent for a taking stock of the present situation with a view to arriving at a definite policy that may be rational and justifiable in the light of existing conditions.

In years past, it will be readily enough admitted perhaps, technical schools devoted more time than was justified to the sort of railway engineering that was then taught. This situation resulted largely from a dearth of better material to constitute a civil engineering curriculum, resulting in the offering of courses in railway drawing of a rather useless sort, in stereotomy, in track maintenance including a study of details that were unintelligible to the average student, and extended practice exercises in railway location surveys. These subjects

have either been eliminated altogether or have been greatly condensed and concentrated, due to the development of more suitable and essential material for study in civil engineering and due to the prevailing increased effectiveness in teaching.

However, a certain amount of railway engineering is retained in all the civil engineering curricula of the larger institutions with perhaps the exception of the university mentioned above. The retention of such courses probably results from two main reasons.

In the first place, the consensus of opinion among educators seems to be that a curriculum should not be fashioned to meet the needs of a particular type of commercial position or a circumscribed group on such positions, and that if the subjects offered have no broader application than to fulfill the requirements of a certain class of positions, they have no legitimate place in a curriculum. Regardless of the outcome of the controversy between professional pedagogists and psychologists as to whether there may be a transfer of formal discipline from one realm of mental activity to another, it has been amply demonstrated that a given mode of attack in the analysis and solution of one class of problems will aid in undertaking another group more or less similar which may be susceptible to a similar mode of treatment. The methods of railway surveys and earthwork calculations are a case in point, inasmuch as they are applicable to any construction line survey, such as railway, highway, irrigation, drainage or other canal, levee work, etc., differing chiefly in that they are the most precise of the group, and that they have been reduced to more definite and scientific procedure. The diversity of their applicability therefore would justify the retention of a certain amount of railway surveys in civil engineering curricula which aim at training for the general practice of the profession.

Studies in the economics of railway location and construction are likewise justified because the same mode of attack is applicable to highway and any other form of transportation engineering, or, for that matter, to determining the economic

significance for any extensive project, and also, because the records and systematic accounting required by the Interstate Commerce Commission render railway operation and performance most readily available for scientific study and analysis. In other words, this type of training and discipline, which is fundamental and of general applicability, can be obtained more advantageously and reliably from studies in railway engineering than in other subjects.

In the second place, even a casual study of history indicates that transportation and communication have been among the most potent factors in the evolution of industry and civilization and the indications are that they will remain so, and hence, for the liberalizing to a certain extent the curriculum, a modicum of railway engineering is desirable. Obviously, in this connection, the railway engineering that is offered should be more than a study of curves and surveys. It should include an inquiry into the factors that limit the capacity of a railway, or, otherwise stated, the harmonious and consistent design of a railway as a manufacturing and commercial enterprise.

Granted then that railway engineering properly forms a part of a general civil engineering curriculum, it may seem desirable to shift the emphasis somewhat from the purely physical considerations to include a certain amount of the economic phases of railway construction, particularly in view of the changed conditions in the railway situation in this country. While there remain many physical problems of the first magnitude in the future of railway engineering, it is the writer's opinion that perhaps the most complex and important problems of the future are largely economic, although entirely within the realm of engineering. The questions are not those of pure economics, but rather of applied economics,—economics that arrives at a definite numerical answer or conclusion.

It is probably true that railway engineering as generally taught and practiced in the past was too much detached from the vitals of railway operation. A railroad is primarily a

plant to manufacture and sell transportation, and railway engineering has been rather remotely connected to either of these processes. Only in the introduction of certain line and grade improvements by means of which heavier tonnage could be hauled has the engineer directly contributed to increasing the plant's capacity to manufacture transportation, and he has seldom had anything to do with increasing the sale of transportation. He has been a rear flagman, as it were, performing a necessary service, but somewhat detached from the main party. As a result, he has been prone to forget his relation to the main plant, and has done little more than—continuing the simile—give backsights when so directed.

The passage of a freight train to many a transitman on maintenance has meant only a brief interruption of his work, a wave of the hand to the engineman, and an indication perhaps of approximately the time of day. Should it stimulate his inquisitiveness and cause him to discover the answers to a number of questions, such as the following for instance, it might bring him to a realization of his relationship to the entire plant. "Is the train that interrupted the work as long as it should be for the grades over this division? Could the division points be changed so as to cause a smaller loss of transportation capacity while passing over intermediate rise and fall? Could traffic be hauled more economically if the grades were reduced? Are all the cars full? Could they be operated full with this character of traffic? Why were there empties in the train? Are empties hauled in the opposite direction also? Where did the cargoes originate? What is their destination? Is this the most economical route? Will the cars return empty or will there be a return traffic available? What could be done to tend to balance the traffic over the line? Does this freight train stand longer on sidings than necessary waiting for passenger or other trains? Should the spacing of sidings be re-adjusted to prevent such loss of time? Is enough time lost to justify an additional track, entirely or at low speed points? What proportion of the time is this rolling stock moving? Could this train be made to follow the

preceding one more closely to advantage by shortening the blocks? What would be the effect on transportation costs if this train were speeded up somewhat? Which does the more damage to the track, this freight or a passenger train? How much more? etc." Such meditations during odd moments might bring the young engineer to a more definite appreciation of his relation to the entire railway plant organization. Indeed, unless the young engineer does enter into vital participation in the operating strategy of the railway, he is likely to find railway engineering a disappointing field of endeavor. Unless he sees more to his work than the aligning of curves, setting of construction stakes, calculation of estimates and detailing minor structures, he will succeed about as well as the structural engineer whose vision is limited to the computation of stresses and the proportioning of parts, or the hydraulic engineer whose capabilities extend only to the determination of head losses and the flow of water. The work offered in railway engineering, therefore, should lead the student to be alert to see the ultimate relationships of the tasks which he may have in hand.

As suggested above, the railway projects of the future will probably be adjusted with a nicety in respect to economic considerations that has not characterized railway engineering in the past. The problems to be solved will be largely those of construction based on a judicious analysis of statistical and economic factors. Radical changes may be expected in the needs of the railways which may give rise to numerous engineering enterprises. The railways are to be regrouped into a certain number of systems in a comprehensively planned scheme on the basis of natural and logical transportation routes, and these routes are likely to be quite different from what they have been previously. Our railways have been largely east and west lines, predicated on the assumption of the Atlantic Coast as offering the only ports of foreign shipping. This condition may be fundamentally changed in the near future to such an extent as to render the old assumption partially obsolete. Already the Panama Canal has made New

Orleans the second export city, and the opening of the Great Lakes to ocean-going vessels via the enlarged Welland Canal making Chicago and other lake cities foreign shipping ports, together with the possible improvement of the lower Mississippi, if found feasible, to admit ocean-going vessels to the middle of the country loading for foreign ports at certain river cities, will profoundly affect the basis on which these groupings are to be adjusted. Our railways will naturally be laid out on a comprehensive unified plan, the basis for which will be controlled largely by the part that America takes in the world's commerce and the arrangement of ports that will afford the most direct shipping, as well as by the conditions affecting domestic traffic.

Because of this regrouping of the railways, extensive improvements will be required in the way of multiple tracking, lines and grade improvement and terminal construction, and the design of these will be based upon an expert analysis of the transportation requirements. While it is out of the question, of course, in the class room to enter into these major problems confronting the railroads, yet many of the general principles determining their solution may be investigated and studied.

Another factor also must be considered in connection with the future railway situation, namely, the improvement of the highways and the development of highway transport, which will inevitably have a potent effect on the character of railway traffic. Unless terminal expenses can be reduced to a marked degree, local freight of small tonnage will be carried by the highways, and under any circumstances, the amount of local freight thus transported will be such as materially to affect certain operating conditions.

Owing to these developments and changes in the railway situation, therefore, the writer is of the opinion that some time that was formerly given to the study of purely physical factors might be appropriately diverted to a consideration of certain more general commercial or economic aspects of the situation. Assuredly the design of location and of terminals,

two elements of prime importance in the recasting of the railways that will occur within the next few years, should receive some attention.

Engineers will be indispensable in this program, for it is incredible that an industry of the magnitude of the railways can be efficiently constructed and operated without the aid of technically trained men. Whether these men will all be on the regular staffs of the railways will largely depend upon the attitude of the railways in regard to the payment of its engineers and to the conditions of service. At the present time, the engineering staffs of the railroads are depleted and young men graduating from college are not attracted to this work—in fact are prejudiced against it—because of the unfavorable conditions that have existed in the past. Three major complaints are lodged against the railways by young engineers: (1) low pay, (2) long working hours including Sundays and holidays without extra pay, and (3) small chance for advancement, especially into administrative and executive offices. If the compensation is made commensurate with the skill and responsibility required, the hours of working placed on a basis similar to that obtaining in other industries, and an opportunity for promotion provided, capable engineers will seek permanent railway service, while on the other hand, if these conditions are not made satisfactory, the more capable men will not enter railway service, for other industries have come to appreciate the value of technically trained men and will offer more attractive opportunities, and in that event, we may expect to find the more intricate and important railway engineering done by consulting engineers of vision and capacity, while the railway staff, inevitably under such circumstances composed of mediocre men, occupied in routine maintenance. This statement is not made in depreciation, for indeed, the condition last mentioned may be in the final adjustment the logical and appropriate one. Cities, water companies, bridge companies, and other industries usually do not retain a large permanent force of high class engineers but for special problems rely on the expert consulting engineer,

depending on their regular forces to attend to routine matters of operation. Already there are evidences of the development of the consultant in railway practice comparable to those in other branches of the profession. Whatever, the engineering organization that may do the work, certain it is that railways will need technical engineers, and it seems no more logical to discontinue instruction in this branch than it would be in water supplies because of the fact that water companies and cities do not generally employ regularly expert engineers. It is as reasonable to prepare men for railway work under consulting engineers as for bridge, municipal or hydraulic work under consulting engineers. Such work would be the legitimate practice of the profession.

In conclusion, it is the writer's opinion that a proper amount of railway engineering should be included in a civil engineering curriculum because of the general applicability of the training derived therefrom, although it may be desirable to shift the emphasis somewhat from the purely physical matters to include certain of the economic phases; and that whether the larger work in railway engineering is done by regular staffs or by consulting engineers makes little difference, the fact remaining that an industry of such magnitude as the railways will always either employ or retain technical engineers of superior skill and capacity.

PRELIMINARY REPORT OF COMMITTEE NO. 18, MINING ENGINEERING.

The general mining engineering profession is less specialized than any of the other engineering professions. Its own field takes in many of the others. Its growth and development have been so comprehensive that its subdivision into Mining Engineering and Metallurgical Engineering is already well advanced, although this Society still holds it under the parent name. The extraction of ores from the earth is especially mining engineering, while the treatment and reduction of ores is especially metallurgical engineering. There are a number of specialized branches of the former, such as coal mining, metal mining, hydraulic mining, etc.; and there are two well defined divisions of the latter into furnace engineering and milling engineering.

The profession in general has to do with civil, mechanical, electrical, hydraulic and chemical engineering; and in addition to the first four of these branches of engineering, it requires in its digging operations knowledge of the science of mining and of geology, and the solution of the problems of handling and controlling stupendous mass weights and movements.

The operating mining engineer will further require a knowledge of business science, and skill in organization and employment.

What then, may we enquire, is the best possible training to be given the undergraduate mining engineer in the time usually alotted, and what shall be done to bring about desired improvements?

Five different topics has been suggested for the discussion of this question, as follows:

1. The standardization of methods of teaching.

2. The improvement of the standard of instructional work.
3. The designation of essential equipments for mining, ore dressing, and metallurgical laboratories.
4. The discouragement of the further establishment of mining schools where not needed.
5. The amplification or revision of the mining section of the report of the Committee on Requirements for Graduation, published in 1904 and 1905, Vols. XII and XIII.

The first has special reference to the coördination of class room and laboratory instruction, laboratory methods, and field practice.

The second topic involves two correlative propositions: on the one hand, the improvement of instructional ability and equipment; and, on the other hand, the improvement of the quality of student. The one is largely a question of compensation and price; the other may be accomplished, perhaps, by careful selection and by reaching back with greater attention to early training. Instructors of the specialized, or applied, subjects should themselves be thoroughly trained in the fundamentals, and understand the relations between the two classes of subjects. Moreover, it would be best if the teachers of the fundamental subjects had a thorough knowledge of the applied; but this would be an impracticable requirement, especially in the large schools giving many different engineering courses.

In approaching the third topic, we may observe that to the engineer a training in capacity for calculation and anaylsis is essential, capacity for manipulation may be convenient: designing and directing are essential, expert tradesmanship is of secondary importance: a knowledge of business science may be acquired: and an understanding of humanity may be cultivated, but the capacity for it must be inborn. The difference between the trade school and the engineering school should be kept in mind. A man may be an expert miner, mill man, furnace man, or assayer, or all of these, and not be a mining engineer. However, it is usually desirable that the

graduate mining engineer should be a good surveyor, or assayor, or chemist, or accountant, etc., in order that he may enter the mining business with a qualification with which he may make himself useful to his employer and incidentally earn a living. The particular line in which the undergraduate may choose to make himself useful may depend upon the branch of mining engineering he wishes to follow, or it may determine for him the branch that he shall follow: but if he is well grounded in the fundamentals, the whole field is open to him.

The essential equipments for the different laboratories are only such machinery and apparatus as illustrate and represent the operations and practices that have become standard, or illustrate some important, fundamental principle. Standard operations and practices that are susceptible to laboratory treatment, are relatively few in number: in mining, they are drilling, blasting, and supporting excavations; in assaying, they are sampling, charging, melting, and cupelling; in ore dressing, they are crushing, classifying, concentrating, and, in some cases, extracting; in metallurgy, leaching and flotation are susceptible to laboratory treatment. But, important, fundamental principles remain matters of individual opinion, and we cannot designate essential equipments for their illustration, except each for himself.

The fourth proposition may be favored on the ground that the establishment of mining schools where not needed is liable to be accompanied with insufficient equipment and support, the employment of inferior instruction, the graduation of men with inferior preparation, and the genèral degradation of the profession. On the other hand it may be urged that such schools, by calling attention to mining engineering education, turn many good men toward the better schools.

We shall introduce the consideration of the fifth topic by giving a summary of that part of the report pertaining to mining engineering, as follows:

	Hours.
Language	400
Mathematics	800
Physics	700
Chemistry, including assaying	800
Geology and mineralogy	700
Drawing and lettering	300
Surveying and mapping	800
Chemical and metallurgical engineering and ore dressing	700
Structural engineering, statical and mechanical, and materials of	600
Mining engineering, principally underground	700
Mining engineering, principally underground, and including organization and management	700
Total hours	7,200

The above is designed to cover a general course for graduation in mining engineering, and the first question that arises pertains to the list of subjects; the second, to the proper distribution of time; the third, the detailed subdivision of the subjects; and the fourth, the arrangement of curricula for different specialized courses in mining engineering, such as Coal Mining Engineering, Metal Mining Engineering, etc. Specialized courses in mining engineering appear to be an actual demand of the times that should be provided.

F. W. SPERR, *Chairman.*
H. H. STOEK,
E. A. HOLBROOK,
J. B. PORTER,
H. E. T. HAULTAIN,
Committee.

A COÖPERATIVE COURSE IN ELECTRICAL ENGINEERING CONDUCTED BY MASSACHUSETTS INSTITUTE OF TECHNOLOGY AND GENERAL ELECTRIC COMPANY.*

BY W. H. TIMBIE,

Associate Professor in Electrical Engineering, Massachusetts Institute of Technology.

The educational scheme known as the Coöperative Plan is not new in itself. That there are distinct advantages in acquiring theory and practice at the same time has long been recognized, and several technical schools, notably those abroad, have been operating on this plan for several years. The College of Science and Arts in Glasgow, the Faraday House in London, and the University of Copenhagen in Denmark, are well-known examples. In this country we are indebted to Dr. Herman Schneider for inaugurating the coöperative work at the University of Cincinnati. Courses similar in detail have been operated by the University of Pittsburgh and by Marquette University at Milwaukee. The only excuse we have for coming before you with the Technology Coöperative Course in Electrical Engineering is that it differs in several important respects from the coöperative schemes of other institutions. It is these differences that I wish to call to your attention, and explain reasons for their existence.

It should be said at the very beginning that the coöperative course herein described was not planned for the purpose of training electrical engineers in every field; and it does not take the place of our old and well-established electrical engineering course, but is an addition thereto for a collateral object. In fact, at present its scope is rather limited. It is avowedly an effort at intensive education and training of

* To be presented at the 28th annual meeting, June 29 to July 2.

electrical engineers to meet a specific demand. Perhaps the easiest way to describe just the field that these men are being trained for is to consider for a moment the various fields in which electrical engineers are needed. We can roughly divide electrical engineers into three rather arbitrary divisions:

First, the consulting engineer, who is usually attached to one or more electrical companies or users of electrical power, to advise them in cases where expert electrical knowledge is needed.

Second, the administrative engineer who may have a large financial responsibility in addition to his duties as electrical engineer. Such a man would be called upon to take the responsibility for the electrical end of any project in the development and utilization of electrical power. In fact, both of these first two types are more closely connected with the development and administration of projects for using electric power than with the manufacture of the machinery involved in such projects, and are in fields which are of themselves of tremendous magnitude, breadth and importance.

In the *Third* division, then, belongs the engineer who is intimately connected with the design and manufacture of electric machinery and accessories. He superintends the design and manufacture of most of the apparatus used by the other two types. His qualifications call for an intimate knowledge of the best manufacturing processes and a thorough training in modern research methods—to which must often be added the ability for creative design. This is the engineer that the Massachusetts Institute of Technology is endeavoring to train by means of its coöperative course in electrical engineering.

And he is not confined to manufacturing electrical appliances. This is the engineer that will be needed in ever-increasing numbers as the country turns more and more to the manufacturing industries in order to sustain itself. The alarming rate at which the natural resources of the country are being depleted has made it imperative that the country at large eventually rely almost entirely upon its manufactures. No longer can we depend upon our exports of raw materials to

pay our bills. These raw materials—lumber, ores, and oils—must be manufactured into finished products if the living expenses of the population are to be met. Our water powers must be utilized and new methods of using our oil and coal more efficiently must be devised. In all this work, manufacturing engineers of the highest type are needed, and become the most valuable asset of the country. It is these men who in the last analysis must direct the operation of the nation's industries. For our industries cannot compete with those of other countries unless they are conducted by men who have large vision, intimate knowledge of manufacturing details, and a thorough training in science and scientific methods. Manufacturing must be conducted on a sound financial basis, which means that processes of production must be so managed that the total cost of the finished article will be low enough to compete with the products of foreign factories. For this task the services of an engineer who has a thorough knowledge of manufacturing processes are invaluable and his duties multifarious. He must not only be familiar with the best methods of production, but he must thoroughly understand scientific research, in order that he may take advantage of new discoveries and continually better his methods of production. This cannot be stated better than in the words of the Governor of Massachusetts, Calvin Coolidge. "Our prosperity comes from our industry and our industry cannot flourish unless it is directed with the highest intelligence. Far more in the future than in the past will this intelligence call for sound training in science and in its innumerable applications to industry."

The General Electric Comapny, as well as other large manufacturing concerns, for years have felt the lack of this type of engineer. They have endeavored to train up in their own organization a corps of men sufficient to fill the ever increasing number of positions of this kind. Now the General Electric Company employs 65,000 men and yearly puts out a manufactured product whose market value is over $250,000,000. From these figures you can gain some idea of the quota of

manufacturing engineers needed by this one company. The normal growth of the company averages 18 per cent per year. To take care of this increased business there is needed an increased force of engineers. When we add to this number the inevitable replacements necessary each year, some idea is gained of how great is the task of training a sufficiently large corps of these high grade engineers. Every large manufacturing concern admits its inability to obtain a sufficient number of these men to meet the yearly demand, especially as the graduate from the usual mechanical engineering and electrical engineering course requires much additional training and experience before he is a good manufacturing engineer.

The coöperative electrical engineering course at the Massachusetts Institute of Technology is an attempt on the part of the General Electric Company and the institute to solve this problem. In this plan the students have the advantage which the institute offers in the way of theoretical and technical training combined with the enormous resources which the General Electric Company offers for practical experience in the manufacture of electric appliances. Most of the theoretical training is given at Cambridge. The greater part of the practical training is given at Lynn, a distance of about ten miles from Cambridge. The course is supervised by a joint committee of the institute and the company. A professor of the institute is associated with an officer of the company in the duty of supervising the progress of the students while at the Lynn Works.

The course covers a period of five years, the first two years being identical with the regular course in electrical engineering at the institute; the last three years being divided between the instruction in theory at the institute and training in manufacturing methods at the General Electric Company. The coöperative features thus occupy only the last three years, starting in the summer after the sophomore year.

While at the works the students are given a fixed payment per week as employees of the company, which payment is the same whatever department of the works may be the one to

which the student is assigned. At the completion of the five year course the students receive the Master of Science degree and the Bachelor of Science degree their graduation taking place at the regular commencement time at the institute.

The first class was limited to thirty members. The class which enters July 6 this year will consist of sixty. The size of future classes may be still greater.

The first week in July, the entire class who have just completed their sophomore year are sent to the General Electric Company's works at Lynn and placed in various shops. Here they remain for thirteen weeks. At the opening of the fall term at the institute, one half of the students return to Cambridge and pursue for one term what is practically the regular course in electrical engineering. At the end of this term they have a vacation of two weeks and then go back to the works of the General Electric Company for further experience. The other group now returns to the institute for further theoretical instruction. This schedule is carried out for three years, each group spending alternately thirteen weeks at the General Electric Company's plant and eleven weeks at the institute. The vacation of two weeks given the students at the end of their period at the institute divides the year into four equal periods of thirteen weeks each. The last period of the fifth year, is spent by both groups at the institute so that the two groups graduate together at the regular commencement time. Yet each group has spent an equal number of weeks in theoretical instruction and practical application.

Now as to the points of difference between this and other coöperative courses. No doubt, on the surface, the most striking feature is in the length of the periods. This, however, is perhaps the least important difference. It was endeavored to arrange the details of the course so that they would fit into a system of education which the founders believe is basic. This system combines the rudiments of Spencer's theory of education with the central idea of Josiah Royce's. It is an endeavor to develop all the desirable sides of a student's mind, character, and body, and at the same time inculcate in him the

spirit of loyalty to his life's work. The course had to be planned so that these several activities would be carried on uninterruptedly throughout those periods which the student spends at the institute and at the works. You will note that in the scheme as outlined, the following activities are carried on continuously throughout the course: Instruction is given in theory, classes are conducted in some humanistic study, time is given and facilities provided for collateral reading, and arrangements are made for physical exercise and recreation. The change therefore at the end of each period does not mean so much a change in occupation as a change in emphasis and the length of the periods thus becomes a rather unimportant detail.

The period of thirteen weeks at the shop and eleven weeks at the institute followed by a vacation of two weeks, was decided upon for the following reasons. It was believed that the period at the works should be long enough for the student to spend in each department an uninterrupted period of sufficient length to become thoroughly familiar with the men, methods, materials and spirit of that department. In some departments the time required for this amount is practically three months, and in others it may be as low as one month. The thirteen weeks' period will therefore meet the conditions required for those departments in which he must spend the longest time and does not prevent him from dividing his time among two or three departments in case he is able to master the details in a shorter time. The same is true concerning the length of the period at the institute. The shortest course at Technology is ten weeks in length, and all longer courses are some multiple of ten weeks. The student is thus able to pursue his studies at the institute in units of standard length. Furthermore, the fact was not lost sight of that at each change some time was lost by the student in getting started on the new work. Therefore, the periods were made of sufficient length to keep the number of changes as low as practicable. Finally it was hoped that the length of the period had been so chosen

that the sojourn at the works would come as a sort of mental relief and recreation from the term's work at the institute. In fact it was hoped that toward the end of the term's work the student would begin to look forward to the change as a welcome break in the routine of study, and on the other hand, that the length of the period at the works would be sufficient to quicken his desire and appetite for further mental concentration and study. The fact is, the thirteen weeks' period has proven that these results have been accomplished. But whether or not a somewhat shorter or longer period would produce the same results has not been experimented with, because the period of thirteen weeks fits into the institute calender in such a way that the periods spent at the institute are practicably coincident with the regular institute terms. So much for the length of period.

The real vital difference, it seems to me, between this course and other coöperative courses conducted in this country, is the fact that the coöperating company recognizes that for three years these students are placed in its plant for the particular purpose of being educated and trained as electrical engineers of a particularly high grade. There is not the slightest effort or inclination on the part of this company to use these students for the purpose of getting out greater immediate production. It is clearly understood that these students are in the shops and offices to learn, and to learn thoroughly, manufacturing methods, and the best relations of labor, mechanism, and materials in high-grade production. Because he can best obtain this knowledge by actually doing the work himself, and because the skill which he attains in any process is the only fair indication of his knowledge of that process, the student is put on the company's pay roll and becomes part of its organization. The length of time spent in each department is regulated not by the needs of that Department but by the value of the experience to the student. As soon as it deemed that he has all the knowledge of the details of the department that a manufacturing engineer should have, he is immediately

changed to another department. This change is made upon consultation between the foreman of the shop, and the officer of the company, and the professor of the institute, who are associated in conducting the course.

It is not to be inferred from this statement that the coöperative students do not work as earnestly and as consistently as the other men in the various departments. The coöperative students are graded on the amount and the quality of the work which they do in the various shops, and as strong inducements to do good work are put before them as are put before the regular workmen. The only difference between their work and that of the other employees is that the students' work is so laid out that they receive a maximum amount of experience from each job and they are kept at it just long enough to enable them to become fairly proficient in the necessary operations. In this way the minimum amount of time is spent in learning the details of manufacture in the different shops, testing departments, drafting rooms and engineering offices.

This spirit on the part of the coöperating company, it seems to me, is the fundamental contribution which this coöperative scheme offers to engineering education. All the other points of difference between this and other coöperative courses are made possible and have their origin in this spirit of the General Electric Company, which, we believe, is the true coöperative spirit. It is the one factor which has allowed us to carry out the plans of the originators and to make such innovations and experiments as we believe will improve the curriculum. I will speak about a few of these innovations more in detail later, but I want it clearly understood that it is not these changes and departures from the ordinary curricula which are the important things in this course, but rather the real coöperation which the General Electric Company has offered us. Do not think, however, that this company has an unselfish motive in this work. The officials of the company frankly confess that they are pursuing this work because they believe that by this method they can procure the future engineers who will be so badly needed by the company and by other industrial

concerns in the near future. It was because they believe that this is the best way to secure these men that they have entered into this scheme, and after one year's trial they report that they are more convinced than ever of the value of coöperative education conducted along these lines.

Perhaps the spirit in which the work is being done is most clearly manifested in the attitude which the officials of the company are showing in their lectures on manufacturing methods. Once a week one of the superintendents has the students come to his office and, in an informal way, talks to them for an hour concerning the details of the work of which he is in charge. This feature was introduced into the course at the suggestion of one of the superintendents and is given entirely upon the superintendent's own time. Some of these men have already prepared six or seven talks on their work, many of them illustrated with lantern slides; some have prepared exhibits of the work in the shops, showing the material in the different stages of manufacture, and arranged in order of the process. Others have arranged to have the students come to their shops in small groups in order to follow through the manufacture of some typical article of their product so that the students may become familiar with the output and the processes before the lecture is given. When one stops to think of the amount of labor and time that is involved for the superintendent who does these things, he can appreciate how the spirit of the originators of the course has permeated the personnel of the works. It also has entered into the attitude of the workmen themselves. I have been surprised, and, I assure you, agreeably surprised, to receive rose-colored reports from the students concerning the willingness of the workmen to help them obtain information about the plant. It would seem impossible for twenty-eight different personalities to mingle with the men of the shops and offices for a whole year and to have not one of them report cases of grouchiness on the part of the other employees of the company. But such has been the case. In fact, the boys report that many times they are embarrassed by the extreme courtesy and eagerness of the

men to show them all about the work and to demonstrate and explain the details of particular processes. All these things, it seems to me, show the degree to which the company has entered into this scheme as a purely coöperative project.

Of course, you must also appreciate that the students have done their share in coöperating. They have in every case entered into the spirit and work of the shops and offices and have quickly become a part of the company. We have paid particular attention to impressing upon the students the great factor which human engineering plays in their chances for success. They are impressed with the fact that nothing is of more importance than to understand the sterling qualities of the men with whom they are working, to study and learn how to adapt themselves to the personal characteristics and eccentricities of the various foremen under whom they are working—that these things will be of the utmost importance when they are in a position to direct the work of others. So during their sojourn at the shop they get experience not only in electrical engineering but also in human engineering and each man's progress along this line is followed carefully by those in charge of the course. Do not get the idea from this, however, that the students are in any way coddled. Here is an excellent chance for them to learn to stand on their own feet with all kinds of fellow workmen and all kinds of foremen, and they are compelled to do so. Of course, they make mistakes and occasionally get into trouble, but it is better for them to make mistakes and get into these few troubles while they are still students under the supervision of the instructing staff of the plant and school rather than later. Each mistake is used as material to impress upon them the value of human engineering. They are thus able to learn valuable lessons without having to suffer too seriously from the mistakes.

Great credit belongs to Mr. Magnus W. Alexander, whose initiative was a principal force in the origination of the plan, and to Mr. C. K. Tripp, Superintendent of Apprentices, of the General Electric Company for the excellent work they have done along these lines. They have worked out highly success-

ful methods for utilizing in the most practical way all the opportunities which the shop work affords for education and training in the human aspect of the job. To be sure, they have thrown themselves enthusiastically into all activities of the work and have brought to the task experience of twenty years in training executives. But in the development of the human side, I believe they have contributed a particularly valuable feature to the educational program of engineers. This discussion is a little aside from the point I was trying to bring out, but I believe it shows how the far-sighted policy of the Coöperating Company allows us to broaden the training in every desirable way.

As the third point of difference from other coöperative courses, I will mention the continuity of the theoretical studies and humanistic subjects. All through the course, both while at the institute and during his sojourn at Lynn, the coöperative student is pursuing the study of electrical engineering theory. At this same time he is taking courses in the study of English. While the main purpose of the latter is to train the engineer in more effective speaking and writing, it also affords opportunities for enlarging his vision and creating new interests. Accordingly when a student goes to the works he continues the study of electrical engineering just as though he were at the institute. During this period, however, we have found that he can comfortably cover only about half as much ground as he would in a like period at the institute. This schedule calls for six hours of study per week and three recitation hours for the two subjects, electrical engineering and English. Thus including the one hour lecture given by the shop superintendent each week, the students spend four hours per week in recitations or lectures. Their schedule at Lynn, therefore, comprises the following:

48 hours per week in shop or offices,
4 hours per week in class room work.
6 hours per week in preparation for class room work.

This schedule allows the student to do all his study in three evenings a week and yet get to bed at half-past nine. There

is still left for him three weekday evenings, Saturday afternoon, Sunday and Sunday evening, for collateral reading and recreation. At the institute his schedule calls for a total of forty-eight hours per week in class room and preparation. Thus while he is at the works the student's weekly schedule is increased from forty-eight to fifty-eight hours of a combination of shop work and mental work. This schedule at the works has proven of advantage in two ways—it has made the period at Lynn contribute to the student's technical knowledge and literary appreciation, and at the same time has kept him in the pink of condition mentally. The scheme may be compared to the system of physical training in which intense physical exercise is alternated with periods of lighter but regular exercise, which keeps the athlete at all times on the tip of his toes. It has been one of the most gratifying results connected with the work to find that our fondest hopes in this direction have been fulfilled. Members of the instructing staff at the institute have commented upon the fine mental condition of the classes returning from their thirteen weeks' stay at Lynn. I believe the opinion is unanimous among their professors that these students are wide awake, have acquired a keen appetite for study and are entering into their work with a new zest. In short, they have what the boys call "pep."

Inasmuch as the material used in the study of English and the method of conducting the English classes is unique, I believe a word concerning this work would be interesting. It is a well known fact that engineering students as a class have an aversion to the study of English for its own sake. So it was felt necessary to arouse an interest in this work before starting it. A plan which was conceived by Professor H. G. Pearson, head of the English and history department at the institute was adopted. At the first session, letters from successful graduates of the institute were read to the class. These letters all brought out the fact that the higher the engineer rises in his profession, the greater is his need to be able to speak well and to write well. Several instances were cited where promis-

ing engineering projects were turned down by committees or boards of directors because the engineers back of the schemes were unable to present their side of the case effectively, while a lawyer who knew nothing about the engineering features was able to talk effectively and persuasively. The class was then formed into a committee or a board of conferees and the session, instead of being called a recitation in English, was called a meeting of the board. At each of its sittings one of the students presided, and two or three members, acting as a subcommittee, presented a report to the board and advocated its adoption. This report generally consisted of some engineering project. For instance, at a typical session, the class was formed into a committee from a manufacturing company about to build a machine shop of a given size, and requiring a definite amount of power for lighting, heating and driving the machinery. Two members of the class, acting as engineers of a company dealing in power plant equipment and supplies, put before the board the advantages of the company owning its own power plant. Two other members of the class representing the local electric power company advocated that the board purchase central station power. After the presentation of each side, the class discussed the matter and finally voted upon the question. The presentation and discussion were made without notes, except for numerical data, etc. At the close of the discussion an instructor in English criticized the session, taking up such points as the work of the presiding officer, showing how he might have avoided some of the difficulties he encountered, and how he might have more easily extricated himself from those he did get into. The effectiveness of the presentation of the subject was taken up from the grammatical, literary, and psychological standpoints, the discussion of the class was commented upon from the point of view of its relevancy, and the vote of the class was criticised as to whether or not the class had really voted upon the merits of the question. A member of the engineering faculty usually discussed the whole subject from an engineering standpoint,

generally as to whether or not a fair statement of the facts had been made. At the succeeding session of the class, a written report was always handed in to the English instructor by the men presenting the projects to the class and by the secretary of the board. During the first period at the works every man in the class had an opportunity to serve on two subcommittees, to preside over the meetings twice, and act as secretary twice.

During the second period at the works, the sessions in English took a different tack. On the previous occasion, emphasis had been placed on effective presentation of engineering projects in the interest of some company for which the student was supposed to be working. During this term's work the emphasis was laid upon the effective selling of one's own services or on interesting capital in one's own project. The instructor took the pains to explain the purpose of this term's work before asking the students to write. He showed them that each letter and each article that they wrote was written for the purpose of producing a certain effect and everything in the letter or article should add to this effect; that any piece of writing was effective only in so far as it produced the result that was desired. A letter written for the purpose of obtaining the writer a job, is effective if it lands the job. A prospectus written for the purpose of selling goods, is effective if it sells the goods. In keeping with this idea, the instructor put forward as the aim of this term's work, effectiveness in writing. Every bit of writing done that term was to have a definite purpose and be written to produce a certain effect. Such exercises as these were used. "Write a description of a dusty room which will make the reader sneeze." "Write a letter asking for an appointment that will make the reader really desirous of seeing you." When the idea and aim of this course was understood, and the purpose of these themes explained, interesting writing competitions arose and work which formerly was looked upon as drudgery became an exciting contest. The class used as a textbook, examples of force-

ful writing contained in a volume of short articles by a well-known reporter.

I have dwelt at considerable length upon this first year's work in English because I am convinced of its importance to engineers. We still have two more years with this class in which to continue the work, and plans are being formulated to develop courses which will so appeal to the engineering student that he will put sufficient effort into the work to make it effective.

To go back to the differences between this coöperative course and others, I should like to mention as a fourth point the provision which is made for further liberalizing the engineering student's education by means of collateral reading. The plan which was adopted for housing the men lends itself very readily to the arrangements for this work. The students, while at Lynn, live together at the Thompson Club, a fine old residence which has been remodeled into a club house with private rooms for individual study, an assembly room for class work, a library, a billiard room, shower baths, etc. The club house forms a center of activities and here all class exercises are held. Advantage was taken of this arrangement to equip the library with a wide assortment of technical books from the institute library, and arrangements were made with the Lynn Public Library whereby several shelves are kept filled with books on all sorts of subjects and in many fields of literature. These books are exchanged from time to time for others suggested by members of the class and by the instructing staff. The sole aim of this part of the library is to make the appearance of the books so attractive and the subject matter so interesting and so accessible as to invite the men to use them. So important do we consider this side of the engineer's education that his program has been laid out with the definite purpose of giving him an opportunity for reading outside of the prescribed courses. We thoroughly believe in the desirability of creating the habit of general reading on the part of the engineer. This is in line with our conviction that if the men with engineering training can be induced to bring this

training to bear on public questions and civic affairs, a great dynamic for good will be put into public life, a dynamic which has behind it all the power of a highly trained mind. This club library, together with the material used in the English course, affords only a beginning, but our efforts have met with gratifying results. At this early date there is evidence of an increased interest in public affairs and a growing appreciation of good literature.

The fifth point of difference which this course offers is the intense spirit of loyalty which has been inculcated in the members of this course; a loyalty to one another, to the institute and to the coöperating company. Several things have contributed to bring these conditions about. First, the closest connection has at all times been maintained between the institute and the group at the plant of the coöperating company. On three or four days each week a member of the electrical engineering department of the institute spends a half day at the plant visiting the various shops and offices to which the students are assigned, or to which they are to be assigned. In this way, as well as by the direct contact which is maintained in the two sessions a week in the class room, the student is made conscious of the supervision which the institute exercises over his work in the shop. To further decrease any sense of separation from the institute, there are always to be found on the library table copies of *The Tech* and *Technology Review*, two student publications of the institute, which help to keep the students at Lynn in close touch with the student life at Technology. Another feature which has not only kept the men closer to the institute, but has made a closer bond between the members of the two groups of coöperative students, has been the practice of having the group at the institute visit the Lynn works on evenings when the officials of the company deliver their lectures on manufacturing methods. During good weather the department of electrical engineering furnished automobiles for the transportation of the men. The members of the group at Lynn were also encouraged to make frequent trips to the institute and to enter into the student activities

there whenever it was possible. For instance, on "Tech Night" at a Boston theatre the group at the works attended in a body.

On other occasions, dinners were arranged at which one of the men acted as toastmaster and others were called upon for ten minute after dinner speeches. These dinners not only formed very pleasant occasions and knit the class closer together, but gave the students opportunities to try out the effectiveness of their English course. I know that the older men in the audience who have been bored nearly to death by after-dinner speeches will not very readily give their approval to this feature, but it must be remembered that young men get a good deal of enjoyment out of such affairs and these dinners were really welcomed as a pleasant break in the routine.

The fact that these students are all taking the same course at the same institution, and are working for the same coöperating company, and finally living together under the very pleasantest conditions, quickly develops this three-fold loyalty. It is this loyalty to the institute and to the company, founded upon the student's conviction that both the institute and the company are planning the work for his highest education and best welfare that in the last analysis must be depended upon to produce results in the way of conscientious and intelligent effort in delivering an honest day's work in the plant and in doing the full quota of study. Finally the coöperating company relies upon this loyalty to influence some of the men in each class to remain with the company after completing the course.

As the sixth point of difference in conducting this work should be mentioned the fact that throughout the three years students are kept in the plant of the same coöperating company. Under the right conditions we feel that this has its decided advantages, because once the officials of the company have determined upon such a policy as the General Electric Company have determined upon in connection with this course, this policy can be maintained and pursued in every department through which the students pass. Of course the

company must be of such a size that it has all the departments in which an electrical engineer needs experience. We are fortunate in our coöperating company. It designs and manufactures electrical and mechanical machinery and apparatus of nearly every description and of the widest range of capacities, and many mechanical devices large and small, some of the most intricate design, the annual selling value of which exceeds two hundred and fifty million dollars. Thus we are able to offer the student a wide choice in the departments in which he is to get his experience as well as in the particular branch he desires to specialize in. This arrangement has the advantage of offering the student the same diversity of work which a large number of smaller companies might offer him, without the disadvantage of a lack of coördination in details and in educational ideals.

The only remaining point of difference I wish to call to your attention is the unusual amount of theoretical work in the course and the fact that a Master's degree is awarded by the institute upon the completion of the five years' work. From the beginning of his freshman year to the end of his post-graduate year, the student pursues one course after another in mathematical physics. In the middle of his sophomore year he starts his work in the principles of electrical engineering and continues it without a break four terms a year for the remaining three and one half years of his course. During the last year the work at the institute is composed of advanced research and creative design, while at the works the student is given experience in the research laboratories of the company, or upon important work in the engineering and manufacturing offices. For a successful completion of this course the institute confers the degree of Master of Science, The degree of Bachelor of Science, conferred as of the year preceding the conferring of the Master's degree, is associated with the Master's degree. In this way the institute shows its appreciation of the value of advanced theoretical training combined with practical experience, which has been intelligently planned and carefully supervised.

THE CONFERENCE BETWEEN REPRESENTATIVES OF INDUSTRY AND EDUCATION, HELD AT DREXEL INSTITUTE.

BY S. P. CAPEN,

Director American Council on Education.

America had no sooner begun to mobilize for the war than it was apparent that whatever surplus of highly trained men existed would shortly be used up. The matter became the object of very serious study at the hands of several groups of people. One of them summoned by the Council of National Defense worked under the chairmanship of Dean Bishop, the Secretary of the S. P. E. E., and developed the outline of the policy for supplying the deficiencies which was later adopted by the War Department.

The war did not end the emergency in the field of higher training. Indeed, there exists today a more serious numerical shortage of young men and women qualified to enter the management end of industry and business than at any previous time of which we have record. The situation is full of portent for the nation. It cannot be remedied over night, but the application of as speedy a remedy as possible is a matter of national concern. No one can be indifferent to it. It is, of course, of the foremost urgency to the leaders of industrial enterprises and to those charged with conducting higher instituions, especially technical colleges.

A study of this situation over a series of months led Dr. Hollis Godfrey, President of Drexel Institute, to consider the advisability of calling a joint conference of educators and industrial leaders. A fitting opportunity presented itself in connection with the annual meeting of the Technology Clubs Associated, which was held at Drexel Institute, March 26 and 27, 1920. This meeting would be, in any event, frequented by representatives both of business and of education. Dr.

Godfrey therefore extended the list of invitees to include a large number of educational and industrial leaders who had no connection with the Technology Clubs.

Representatives were present from the following industries: Rubber, textiles, cotton finishing, shoes and leather, machinery and metals, paints and oils, paper, and public utilities. On the educational side there was a committee of the American Council on Education specially appointed to attend the meeting, and a large number of delegates from leading colleges and universities.

The purpose of the meeting as stated in the announcement was to "write a joint specification of the present-day educational needs of American commerce and industry and the expression of those needs to the higher institutions of the United States." In other words, it was proposed to meet the present emergency in a manner similar to that in which the war emergency was met. It was proposed that industry should define its needs, that higher institutions should accept the definition and should undertake to fill these needs. It was proposed finally to set up machinery which would enable the representatives of education and the representatives of industry to consult together periodically concerning the training of men and women for industrial and business purposes.

The discussion showed that before such periodic consultations could be provided for, there must be preliminary organization of the two parties concerned. Educational institutions and associations have already formed an organization which enables them to act with a certain degree of unity in a large national matter such as that proposed. The newly established American Council on Education is the central organization in which all of the chief national educational associations are represented. Its general object is to promote and carry out coöperative action in matters of common interest to the associations and institutions composing it. No similar organization exists in industry. The convention regarded the creation of such an organization as the first step

toward the practical working out of the problems presented to it. It therefore passed the following resolutions:

Resolved, first, that each of the industrial groups represented in this movement for the writing of a joint specification by industry and the colleges appoint a committee, one of whose members shall act as a delegate to a *Central Council*.

Resolved, second, that this Council shall appoint a coöperating committee to act with the committee designated by the American Council on Education.

Resolved, third, that these two committees shall act as a joint clearance committee to advance the drawing up of specifications as to the qualifications of college trained men and women needed by the several industries, disseminating both to the colleges and the industries the information necessary to secure an increase in quantity and a betterment of quality of the output of the colleges.

Resolved, fourth, that Dr. Hollis Godfrey call the first meeting of the Council, acting as its temporary chairman.

The function of the joint committee provided in the third resolution above will be:

1. To define for the benefit of the industrial groups the type of educational specifications that will be acceptable to the colleges and that will fit the conditions of collegiate organization.
2. To review the specifications submitted by the educational committees of each industry.
3. To circulate them, with comment, among the higher institutions.

Some 150 industrial firms have made financial contributions for the furtherance of this plan. The necessary steps for the organization of the industrial council for coöperation with the colleges are now being taken.

EDITORIAL.

The Federated American Engineering Societies.—There was adopted in Washington at a conference of a large number of engineering societies, a constitution of the proposed national engineering organization known as "The Federated American Engineering Societies." The object of this organization is to further the interests of the public through the use of technical knowledge and engineering experience and to consider and act upon matters common to the engineering and allied technical professions.

This object, as stated, is of more than ordinary interest to the public as well as to the members of engineering professions. It states in a very practical way the fact that the engineer stands primarily for service to his fellowmen, rather than the desire to further his own advancement.

Including, as this organization undoubtedly will, practically all the engineering societies in the country and providing funds, although not ample to carry on the work of the organization, it possesses the elements of a great force in public welfare. It is unnecessary to call to mind the fact that the engineer usually shows so much interest in his own profession, especially the technical features thereof, that he fails to perform his duties as a public servant. This organization proposes to perform for engineering societies those public services for which the technical societies composing the organization have failed thus far to do. We can only hope that arrangements may be made by which the Society for the Promotion of Engineering Education may become a charter member of this organization. It seems to the writer that the duties of the organization must be to a certain extent divided among the various national and local engineering organization constituting its membership. Briefly speaking, the matter of education and its relation to the engineering profession should be considered by the S. P. E. E. In other words, the S. P. E. E. should constitute to all intents and purposes a standing committee on education of The Federated American Engineering Societies.

BOOK REVIEWS.

The Study of Electricity by the Deductive Method. GEORGE I. ALDEN, B.S., M.M.E., Worcester, Mass., 1919, Commonwealth Press. Pages 110.

The fundamentals of Electricity may be taught in many different ways, depending upon the ability and preparation of the student. All teachers of the subject make use of various mechanical analysis from time to time, the oldest and possibly the most common being the water comparison, most anlaysis being more or less specialized for the particular phase of the subject under discussion. The author in this work makes use of an endless flexible shaft revolving about its geometric axis as an analogy for electrical transmission of energy. The idea is developed in such a way as to make it applicable to the fundamental electrical and magnetic principles. H. E. D.

Structural Drafting and Design of Details. By CARLTON THOMAS BISHOP, C.E., Assistant Professor of Structural Engineering, Yale University. First Edition, 1920, John Wiley & Sons, Inc.

This is a very carefully compiled book of 352 pages, 8 x 10 inches. It is intended for students in the elementary study of structural designing and drafting. Also as a convenient reference book for general use in commercial drafting rooms. There are sixty-four chapters of text including many illustrations and full-page structural drawings. Also thirty-six pages of tables and diagrams.

The book is well arranged as to sequence of subjects, manner of presentation, and amount of space devoted to the various subdivisions of the subject. It is clearly written and should readily appeal to any beginner in the subject. The illustrations and drawings have been carefully prepared and

serve the purpose intended admirably. The author does not follow the case method extensively by presenting fairly complete designs of structures, but tends toward isolating the subdivisions and treating them independently. This can hardly be called a criticism in an elementary book of this character.

The tables and diagrams are very conveniently arranged and contain practically all of the standard data necessary in ordinary structural drawings. Several diagrams for graphic determination of resultants from two given components, and very complete tables and rivet values may be especially mentioned. J. H. S.

COLLEGE NOTES.

The Pennsylvania State College.—The summer course in industrial management will be given for the fifth consecutive year and is intended for superintendents, foreman, accountants and similar factory executives. It consists of an intensive course covering all phases of factory organization and management and will be given between August 9 and 21. A descriptive circular will be sent on request by addressing Professor Edward J. Kunze, head of the department of industrial engineering.

Wyoming School of Mines.—Dr. A. C. Boyle, Jr., for ten years professor of mining, metallurgy and economic geology, has been appointed geologist for the Union Pacific Railrad Company. He will resign his present position and will assume the duties of his new office about June 15. Mr. Boyle received his early training at Utah University, later attending Cornell University, and finally receiving the degree of doctor of philosophy from Columbia University School of Mines, N. Y., in 1913.

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